(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 411 126 A1**

(12) **EUROPEAN PATENT APPLICATION published in accordance with Art. 158(3) EPC**

(21) Application number: 89904303.8

(22) Date of filing: 27.01.89

(86) International application number: PCT/SU89/00029

(87) International publication number: WO 90/08871 (09.08.90 90/19)

(51) Int. Cl.5: E04H 5/02, E04B 1/18, B66C 23/20

(43) Date of publication of application: 06.02.91 Bulletin 91/06

(84) Designated Contracting States: AT DE FR GB SE

(71) Applicant: TSENTRALNY NAUCHNO-ISSLEDOVATELSKY I PROEKTNO-EXPERIMENTALNY INSTITUT PROMYSHLENNYKH ZDANY I SOORUZHENY (TSNIIPROMZDANY)
Dmitrovskoe shosse, 46Moscow, 127238(SU)

(72) Inventor: BULGAKOV, Sergei Nikolaevich
ul. Belovezhskaya, 1-64
Moscow, 121353(SU)
Inventor: CHEREVKO, Vladimir Petrovich
ul. 9-ya Parkovaya, 40-258
Moscow, 105264(SU)
Inventor: NAZAREVSKY, Nikolai Ivanovich
ul. Shushinskaya, 4-14
Moscow, 129327(SU)
Inventor: SAMOFATOV, Alexandr Grigorievich
ul. Pobedy, 18-39
Belgorod, 308000(SU)

(74) Representative: Godwin, Edgar James et al
MARKS & CLERK 57-60 Lincoln's Inn Fields
London, WC2A 3LS(GB)

(54) **SINGLE-STOREY MULTISPAN MODULE INDUSTRIAL BUILDING.**

(57) In an industrial building each module (1) comprises four cells (6) each having a square shape in plan and located in pairs symmetrically in relation to the central axes of the module. In the centre of each module (1) is mounted a tower crane secured to a foundation (2) and provided, on its vertical tower, with a horizontal platform (10) intended to support the ceilings (4) of the cells (6) of the module.

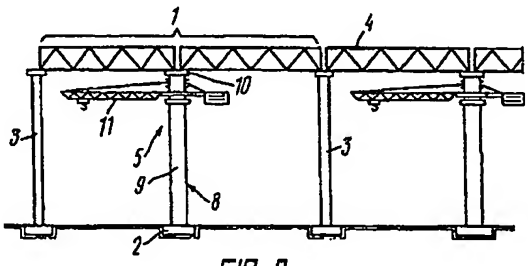

FIG. 2

EP 0 411 126 A1

ONE-STORY MULTIPLE-SPAN MODULAR INDUSTRIAL BUILDING

Technical Field

The invention relates to the construction, and in particular it deals with a one-story multiple-span modular industrial building which may be used in various industries such as mechanical engineering, construction industry, food and light industries, for warehouses, storage facilities and various agricultural projects.

Background of the Invention

One-story industrial buildings with the span-type lay-out and with reinforced concrete, steel or miscellaneous load-bearing framings and panel enclosure structures are preferably used nowadays for the industrial construction.

These industrial buildings feature comparatively small size of spans and post spacing so that effective utilization of production areas for the accommodation of production equipment and optimum arrangement of such equipment are restricted. Load from crane equipment in such buildings is generally transmitted to framing structures thus resulting in their heavy weight, limiting further increase in the span and post spacing and hampering engineering requirement and modernization of production facilities without substantial investments in the reconstruction of the construction part of buildings.

Known in the art are one-story multiple-span modular industrial buildings (Arkhitektura grazhdanskikh i promyshlennykh zdanii, Moskva, Stroiizdat, 1986, pp. 74-75. A module of the building includes foundations, posts, roof structures supported by the posts, and crane equipment. Traveling bridge cranes are mainly used in such buildings as handling and hoisting devices, the crane load being transmitted to the building framing. The need to provide crane tracks (crane beams, rails) calls for a large consumption of materials (steel, reinforced concrete) and labour effort for regular crane track lining during operation of buildings.

Zones inaccessible for servicing with the crane equipment that cannot be used for the accommodation of production equipment are formed along longitudinal center-lines of each line of posts. In addition, large size of traveling bridge cranes calls for an increase in height of industrial buildings.

Summary of the Invention

The object of the present invention is to provide such a one-story multiple-span modular industrial building wherein independent designing of its structural and technological portions would create a shop space with widely-spaced posts, whose areas and volumes would be sufficient for technological and structural production layout yielding themselves easily to subsequent updating and replacement of technological equipment.

The above object is accomplished by that in a one story multiple-stage modular industrial building in which each module includes foundations, posts, roof structures supported by the posts, and crane equipment, according to the invention, the posts within each module are installed in such a manner as to form four cells square-shaped in the plan view which are positioned pair-wise symmetrically with respect to the central axes of the module, the crane equipment comprising a tower crane installed at the center of the module, secured to the foundation and having its vertical mast provided with a horizontal land for supporting a roof structure of the cells.

According to one embodiment of the invention, a monorail is preferably mounted in each module, on the underside of the roof structure, the monorail being in the form of a ring coaxial with the vertical mast of the tower crane, support rollers supported by the monorail being provided at the end of a crane boom.

According to another embodiment of the invention, in which the tower crane is provided with ac counterweight, a monorail in the form of a ring is preferably mounted on the underside of the roof structure coaxially with the vertical mast, the counterweight having support rollers engageable with the monorail, the boom and counterweight being connected to the vertical mast by means of pivotal joints for rotation in a vertical plane. The tower crane boom is preferably provided with an extensible section.

The abovedescribed construction of modules of the building makes it possible to obtain a hall-type building with a small number of supports as the posts of each cell are only provided at the corners of the tower crane.

The provision of the crane equipment in the form of the tower crane rigidly mounted on a foundation makes it possible to eliminate loads from the crane equipment on the building framing and to use its vertical mast for taking up load from the roof structure of the building. All this allows material usage in the building to be decreased and its structure made lighter in weight whereby the post spacing can be increased. The latter allows

optimum conditions to be provided for the arrangement of production equipment with a fuller utilization of production areas and reduction of the building area for unit of production capacity since the boom of the tower crane can be used during rotation for servicing the zones of all four cells, and the areas of the zones that cannot be serviced by the crane are reduced. All this makes it possible to erect the building structures irrespective of production facilities accommodated therein and without capital investment in further reconstruction for modernizing and replacement of production equipment accommodated in the building.

In addition, this construction of each module

makes it possible to provide modules with different post spacings and height so that buildings of various configurations and overall dimensions can be erected to suit the desired lay-out scheme.

The provision of the ring-shaped monorail mounted on the underside of the roof structure for supporting the boom or counterweight makes it possible to lower loads on the crane mast, increase lifting capacity of the crane and provide more favourable conditions for operation of the crane.

The provision of the crane boom with an extensive section allows the zone serviced by the tower crane of each cell of the module to be enlarged, and loads can also be transferred to the neighbouring modules.

Brief Description of the Drawings

The invention will now be described with reference to specific embodiments illustrated in the accompanying drawings, in which:

Figure 1 is a general view of a fragment of an industrial building according to the invention, a plan view;

Figure 2 is a sectional view taken along line II–II in Figure 1;

Figure 3 is a detail of attachment of a boom to a vertical mast of a tower crane;

Figure 4 one of modules of the building shown in Figure 1 having a monorail for supporting a tower crane boom mounted on the underside of a roof structure, a plane view;

Figure 5 is a sectional view taken along line V-V in Figure 4;

Figure 6 is a detail A in Figure 5, an enlarged view;

Figure 7 is another embodiment of a module of a building having a monorail for supporting a counterweight of a tower crane mounted on the underside of a roof structure, a plan view;

Figure 8 is a sectional view taken along line VIII– -VIII in Figure 7;

Figure 9 is a detail B in Figure 8, an enlarged view;

Figure 10 a view along arrow C in F gure 9;

Figure 11 is an embodiment of a support on a counterweight;

Figure 12 is a detail D in Figure 8, an enlarged view;

Figure 13 is a sectional view taken along line XIII-XIII in Figure 12;

Figure 14 is ditto of Figure 13, under the action of load on the crane.

Best Mode for Carrying Out the Invention

A one-story multiple-span modular industrial building is made up of modules 1 (Figure 1) each having a foundation 2, posts 3, a roof structure 4 (Figure 2) supported by the posts 3, and a crane equipment 5. 1 Each module 1 (Figure 1) of the building is formed by four cells 6 square-shaped in the plan view which are positioned pairwise symmetrically with respect to central axes 7 of the module 1 and hav a common central post 8.

The crane equipment 5 (Figure 2) positioned at the center of the module comprises a tower crane secured to the foundation 2 and has a vertical mast 9 which is the central post 8 of the module 1 and which has a horizontal land 10 for supporting the roof structure 4 of the cells 6.

The roof structure 4 of each cell 6 is in the form of a conventional structure.

A boom 11 of the tower crane is located under the roof structure 4 and is installed on a table 12 (Figure 3) mounted for rotation through 360° on the vertical mast 9 in any appropriate known manner, e.g. by means of rollers supported by a stationary support ring 13.

To reduce load on the vertical mast 9, i.e. on the central post 8 of the module 1, a monorail 14 (Figures 4,5) is mounted on the underside of the roof structure 4 in each module 1, the monorail having the I-section (Figure 6) and being attached to the roof structure 4 by any appropriate known means, e.g. by means of bolts 15.

The monorail 14 (Figure 4) is in the form of a ring coaxial with the vertical mast 9 of the tower crane.

A support 17 is mounted at the end of the boom 11 by means of seamless joints and carries support rollers 18 supported by the lower flange of the monorail 14 and a known per se drive 19 for rotating the support rollers 18.

The monorail 14 is made with a radius equal to the distance from the axis of rotation of the boom to the axis a-a of the support rollers 18.

If the tower crane has a counterweight 20 as shown in Figure 7, an auxiliary support is also provided on the underside of the roof structure 4 in

the form of a monorail 21 shaped as a ring coaxial with the vertical mast 9 and attached by any appropriate known means to the roof structure 4.

The counterweight 20 (Figures 9,10) carries a movable support 22 which may have a single roller 23 having its axle installed in a mounting arm 24 secured to the counterweight 20 or a plurality of rollers 25 (Figure 11) mounted along an arc of a radius corresponding to the radius of the ring of the monorail 21, the radius of the ring of the monorail 21 corresponding to the distance from the axis of rotation of the boom of the tower crane to the axis b-b of the movable support.

One roller 23 or a plurality of rollers 25 are engageable with the monorail .21 during movement of the counterweight 20 upwards (during lifting of a load by the crane). If there is no load suspended from a boom hook, a space 26 is defined between the movable support 22 and the monrail 21.

The boom 11 (Figure 12) and the counterweight 20 are connected to the revolving table 12 of the vertical mast 9 by means of pivotal joints 27 of any appropriate known type which allow the boom 11 and counterweight 20 to rotate in a vertical plane so as to ensure the engagement of the support 22 with the monorail 21 only if there is a load at the crane hook.

The boom 11 and the counterweight 20 are supported by means of cables 28 connected to struts 29. The struts 29 are attached by means of pivotal joints 30 to the revolving table 12. The struts 29 having their upper portions connected to a cage 31 put on a top part 32 of the vertical mast 9 and having movable supports 33 (Figure 13) in the form of rollers mounted in a known per se manner on the cage 31 on the side of each strut 29, and a movable support 34 also in the form of a roller mounted on the cage 31 an on the side of the boom 11 of the crane. A space 35 is defined on the side of the counter weight 20 between the top part 32 of the upper support and the cage 31.

The boom 11 of the tower crane shown in Figures 4 and 7 has an extensible section 36 moving along rollers 37 (Figure 6) mounted on the boom 11 by means of any appropriate known drive 38, e.g. a rack-and-pinion or hydraulic drive. A lifting hook 39 is provided at the end of the extensible section 36 so as to supply loads by extending this section into zones of a module which are outside the range of the boom 11 of the tower crane or to transfer a load to the neighbouring modules.

The tower crane is controlled by any appropriate known manner by an operator from a cabin (not shown in the drawings) provided on the vertical mast of the tower crane or in any other appropriate manner.

The structural solutions according to the invention make it possible to provide a one-story modular industrial building in which each module has a hall-type lay-out which is most suited for optimum arrangement of production equipment that can be serviced by a single tower crane within one module.

The central post 8 (Figure 2) of the module 1 in the form of the vertical mast 9 of the tower crane takes up not only crane loads, but also loads from the roof structure 4 of the cells 6 of the module 1.

The boom 11 of the tower crane may perform fullswing rotation in any direction through 360°. If it is necessary to transfer loads outside the range of the boom, including to the zones in the neighbouring modules, the extensible section 36 (Figure 6) is used which increases the range of the crane.

Owing to the provision of the support rollers 18 provided on the distal end of the crane boom supported by the monorail 14 no tilting moment is created by the load acting upon the hook 39 or 40 of the crane. The crane lifting capacity can be thereby increased.

When the crane boom is rotated without a load suspended from its hook 40 as shown in Figure 9, the movable support 22 of the counterweight 20 does not engage the monrail 21, and the space 26 is defined therebetween.

When a load is suspended from the hook 40, the boom 11 (Figure 12) and the counterweight 20 are rotated in a vertical plane owing to the provision of the pivot joints 27 through an angle determined by the space 35 defined between the top part 32 of the vertical meat 9 and the cage 31. The counterweight 20 and the boom 11 are rotated until the rollers of the movable support 22 come into engagement with the monorail 21. A space β - (Figure 14) is thus defined between the movable support 34 and the top part 32 of the vertical mast 9.

The amount of space β is determined by the formula $\beta = \frac{\gamma h}{L}$, wherein γ is the space 26 between the monorial and the movable support 22, L is the horizontal distance from the pivot joint of the counterweight to the axis b-b of the movable support (Figure 8), h is the vertical distance from the pivot joint 30 to the movable support 34 in the cage 31 (Figure 12).

When a load is applied to the crane hook, a bending moment imposed by this load is not transmitted to the crane mast and to the foundation supporting the crane and is compensated for by a force acting upon the monorail 21 engaged by the movable support 22. This force is directed upwards and does not create any additional load on the roof structure 4, i.e. it may be taken up by the roof structure without its reinforcement, and the crane stability against tilting is enhanced so that the lifting capacity of the crane can be sincreased.

Therefore, the construction according to the invention makes it possible to erect industrial buildings withs rational utilization of the building volume owing to minimum approach range of the tower crane boom to the roof structure, fuller utilization of production areas with permanent servicing of all production sections and cells of the module by means of a single tower crane including the zones outside the boom range owing to the employment of the extensible section. At the end of the day, a possibility is provided of erecting general-use production buildings of any size using various three-dimensional combinations of modules in the building.

The three-dimensional construction of the building according to the invention allows further modernization and replacement of production equipment to be carried out in most efficient manner.

Industrial Applicability

The production buildings of this type can be used in various industries, in the mechanical engineering, construction industry, food and light industry, for warehouses and storage facilities and for various agricultural projects.

Claims

1. A one-story multiple-span modular industrial building wherein each module (1) comprises foundations (2), posts (3), roof structures (4) supported by said posts (3) and crane equipment (5) characterrized in that the posts (3) are installed in each module (1) so as to form four cells (6) square-shaped in plan view and arranged pairwise symmetrically to the central axes (7) of the module (1), having crane equipment (5) installed at the centre of said module (1) in the form of a tower crane secured on the foundation (2), the vertical mast (9) of said module (1) being provided with a horizontal platform (10) for supporting the cell roof structure (4).

2. A one-story multiple-span modular industrial building as claimed in Claim characterized in that it comprises a monorail (14) mounted on the underside of the roof structure (4) in each of said modules (1) and has the form of a ring coaxial with the vertical mast (9) of the tower crane, whose boom (11) carries support rollers (18) at its end riding over the monorail (14).

3. A one-story multiple-span modular industrial building as claimed in Claim characterized in that in the version of the tower crane with a counterweight (20) the monorail (2) mounted on the underside of the roof structure (4) has the form of a ring coaxial with the vertical mast (9) and the counterweight (20) carries a movable support engageable with said monorail (21), the boom (11) and counterweight (20) being articulated with the vertical mast (9) by pivot joints (27) with a provision for turning in a vertical plane.

4. A one-story multiple-span modular industrial building as claimed in Claims 1-3 characterized in that the tower crane boom (11) is provided with an extensible section (36).

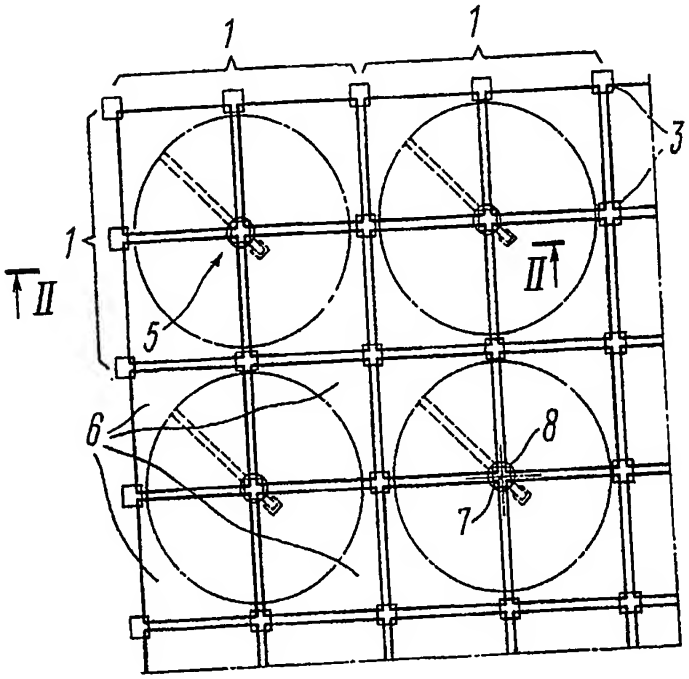

FIG. 1

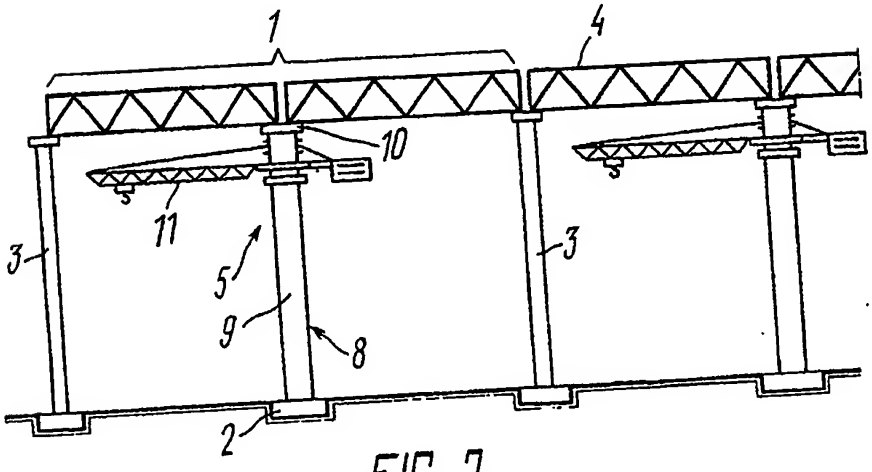

FIG. 2

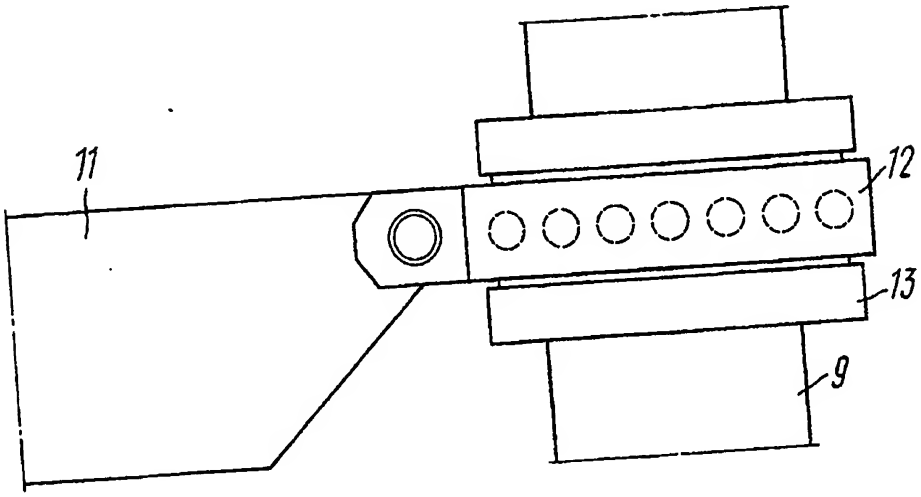

FIG. 3

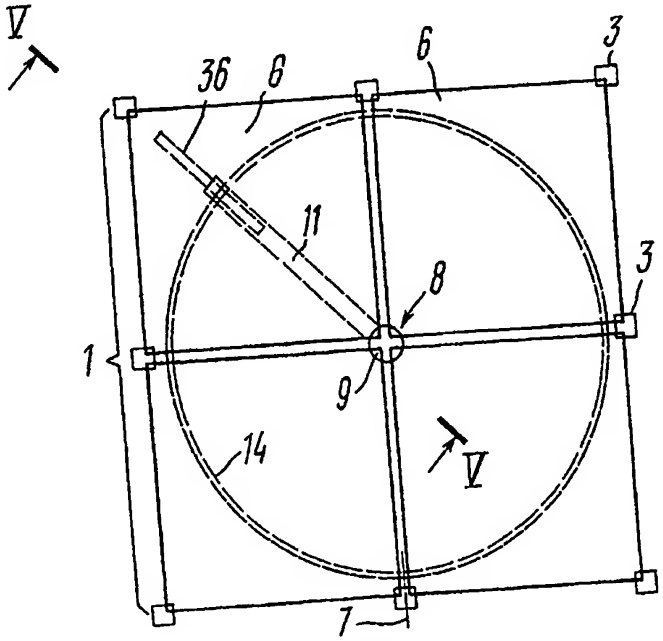

FIG. 4

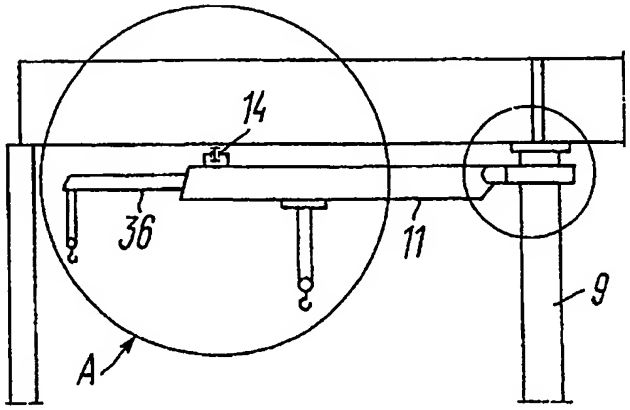

FIG. 5

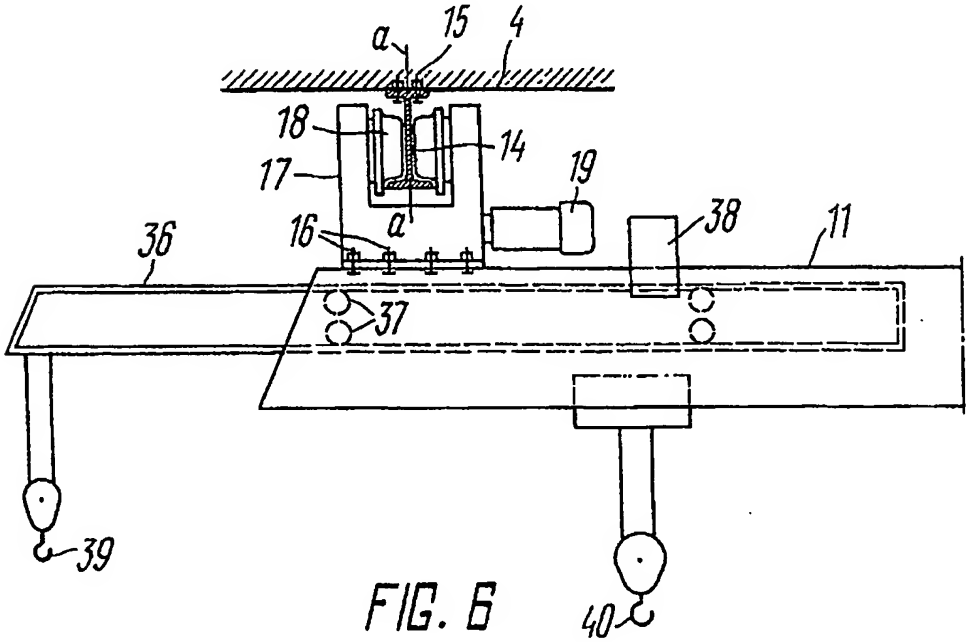

FIG. 6

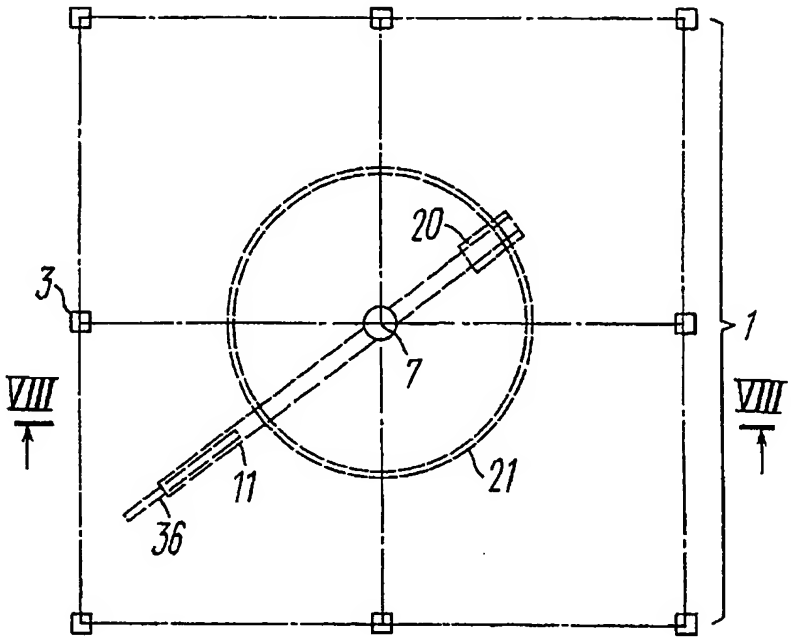

FIG. 7

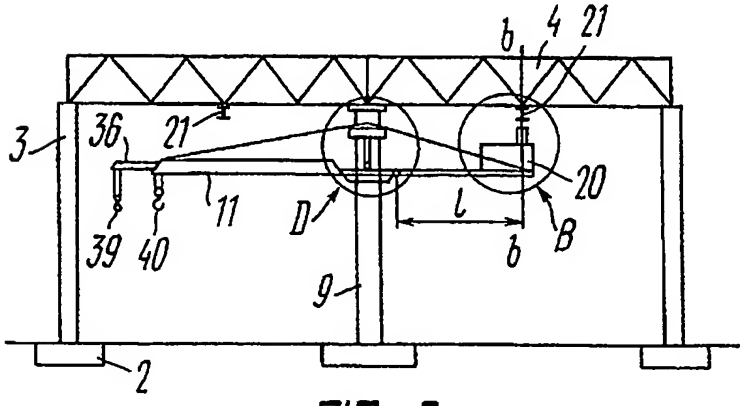

FIG. 8

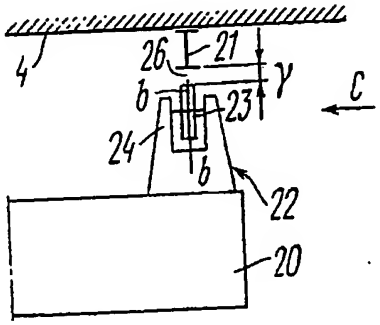

FIG. 9

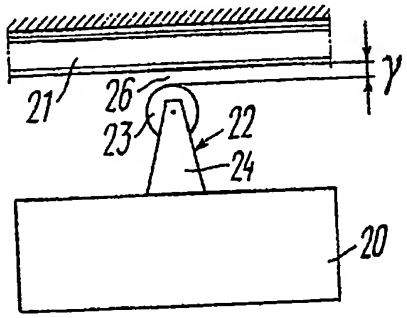

FIG. 10

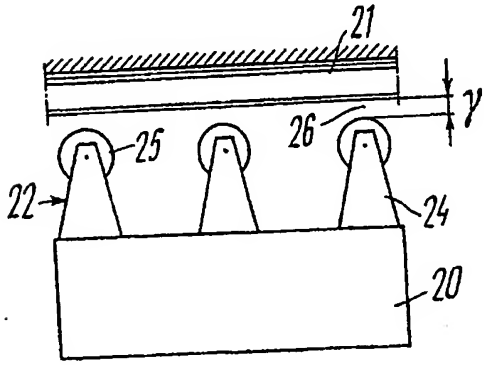

FIG. 11

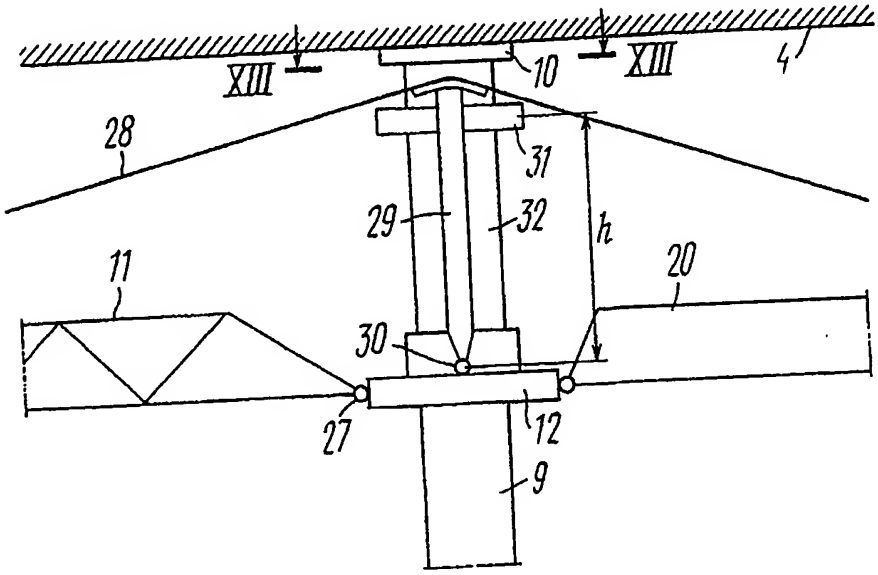

FIG. 12

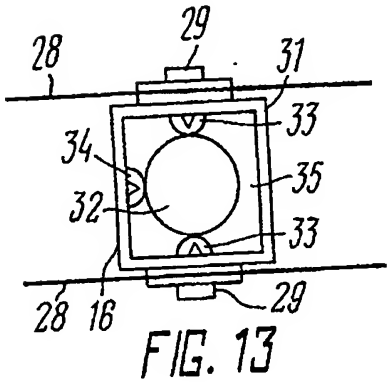

FIG. 13

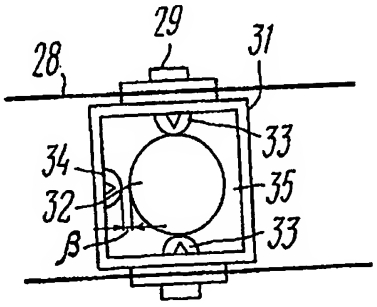

FIG. 14

INTERNATIONAL SEARCH REPORT

International Application No PCT/SU 89/00029

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: E 04 H 5/02, E 04 B 1/18, B 66 C 23/20

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]:	E 04 H 5/00 – 5/02, E 04 B 1/00 – 1/18, B 66 C 23/00 – 23/20

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	S.V. Dyatkov "Arkhitektura promyshlennykh zdany", 1984, Vysshaya shkola" (Moscow), pages 77,97,304	1–2
A	SU, A1, 289716 (TSENTRALNOE KONSTRUKTORSKOE BJURO "STROIMASH"), 5 May 1973, figure 1	1,3
A	SU, A1, 1100220 (KIEVSKY FILIAL PROEKTNO-TEKHNOLOGICHESKOGO INSTITUTA "ENERGOMONTAZHPROEKT"), 30 June 1984, figures 1–2	1
A	SU, A1, 945331 (TSENTRALNY NAUCHNO-ISSLEDOVATELSKY I PROEKTNY INSTITUT STROITELNYKH METALLOKONSTRUKTSY "TSNIIPROEKTSTALKONSTRUKTSIA"), 23 July 1982, fig. 1,3	2
A	SU, A1, 46 6168 (VSESOJUZNY NAUCHNO-ISSLEDOVATELSKY INSTITUT STROITELNOGO I DOROZHNOGO MASHINOSTROENIA), 6 August 1975, figures 1–2	4
A	SU, A1, 308967 (P.A. KUDRYAVTSEV ET AL.), 6 September 1971, column 3	1

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
29 August 1989 (29.08.89)	12 October 1989 (12.10.89)
International Searching Authority	**Signature of Authorized Officer**
ISA/SU	

Form PCT/ISA/210 (second sheet) (January 1985)